Amendments to the Specification:

Paragraph beginning on page 1, line 15

In recent years, the world has witnessed explosive growth in the demand for wireless communications and it is predicted that this demand will increase in the future. There are already over 500 million users that subscribe to cellular telephone services and the number is continually increasing. Eventually, in the not too distant future, the number of cellular subscribers will exceed the number of fixed line telephone installations. Already, in many cases, the revenues from mobile services already exceeds that for fixed line services even though the amount of traffic generated through mobile phones is much less than in fixed networks.

Paragraph beginning on page 3, line 14

An example of an outer decoder is a convolutional decoder that utilizes the Viterbi Algorithm. The Viterbi ~~algorithm~~ Algorithm is widely used in communication systems and has been adapted to perform functions including demodulation, decoding, equalization, etc. Many systems utilize the Viterbi Algorithm in both the inner and outer decoding stages.

Paragraph beginning on page 3, line 18

For example, consider a receiver adapted to ~~handle~~ receive a GSM or GERAN signal. Such a system utilizes convolutional coding for performing Forward Error Correction (FEC) over channels that require equalization. The equalizer and outer FEC decoder typically used employ the Viterbi Algorithm in their operation.

Paragraph beginning on page 3, line 22

There ~~exist~~ exists a class of decoders that provide improved performance by utilizing soft information about the received symbols rather than only hard decisions. Examples include turbo decoders and soft decision convolutional forward error correction decoders utilizing the Viterbi Algorithm, etc. The advantage of a Viterbi decoder is that it can efficiently process soft decision information. This class of decoders provides better performance by taking into account soft information about the reliability of the received symbol. The improved performance of the decoder cannot be realized, however, when soft information about the received symbols is not available.

Paragraph beginning on page 5, line 23

A key feature of the present invention is that the noise variance is used in computing soft output values, thus resulting in better overall performance of the receiver. In many real world systems, the noise statistic varies with time and cannot be assumed to be constant. The present

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invention thus provides a mechanism to estimate the noise power and use it to normalize soft decision information subsequently input to the soft decision based outer decoder. It is noted that the present invention performs the normalization process using a relatively low complexity technique.

Paragraph beginning on page 7, line 10

There is also provided in accordance with the present invention a communications receiver for receiving and decoding an *M*-ary transmitted signal comprising a radio frequency (RF) front end circuit for receiving and converting the ~~M-ary~~ *M*-ary transmitted signal to a baseband signal, a demodulator adapted to receive the baseband signal and to generate a received signal therefrom in accordance with the ~~M-ary~~ *M*-ary modulation scheme used to generate the transmitted signal, a first decoder operative to receive the received signal and to generate a sequence of soft symbol decisions therefrom, a normalization mechanism comprising processing means programmed to generate a first noise power estimate based on a training sequence transmitted along with data over the communications channel, generate a second noise power estimate derived from the data transmitted over the channel, generate at least one performance based metric based on the reception of the training sequence or on the reception of the data, calculate a combined noise power estimate as a function of the first noise power estimate, the second noise power estimation and [[the]] at least one metric, modify the soft decisions in accordance with the combined noise power estimate so as to yield normalized soft decisions and a second decoder adapted to receive the normalized soft decisions and to generate binary received data therefrom.

Paragraph beginning on page 10, line 5

AMPS   Advanced Mobile ~~Telephone~~ Phone System

Paragraph beginning on page 11, line 27

The symbols output from the mapper are input to the modulator [[38]] 57 which functions to receive symbols in the *M*-ary alphabet and to generate the analog signal therefrom that is subsequently transmitted over the channel 59. The channel may comprise a mobile wireless channel, e.g., cellular, cordless, fixed wireless channel, e.g., satellite, or may comprise a wired channel, e.g., xDSL, ISDN, Ethernet, etc. It is assumed that noise is present and added to the signal in the channel. The transmitter is adapted to generate a signal that can be transmitted over the channel so as to provide robust, error free detection by the receiver.

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Paragraph beginning on page 12, line 16

Several methods of channel estimation that are known in the art and suitable for use with the present invention include, for example, a correlation method and a least squares method. The correlation method is described in detail in "GSM System Engineering," A. Mehrotra, 1997, Chapter 6 and in the article "On the Minimization of Overhead in Channel Impulse ~~response~~ Response Measurement," Y. Han, IEEE Transactions on Vehicular Technology, Vol. 47, No. 2, May 1998, pages 631-636. The least square method of channel estimation is described in more detail in the articles "Improved Channel Estimation With Side Information," A.S. Khayrallah, R. Ramesh, G.E. Bottomley, D. Koilpillai, IEEE, March 1997, pages 1049-1051 and "Impact of Blind versus Non-Blind Channel Estimation on the BER Performance of GSM Receivers," D. Boss, T. Petermann, K. Kammeyer, IEEE Signal Processing Workshop on Higher-Order Statistics, July 21, 1997, pages 62-67 and in the book "Adaptive Filter Theory," S. Haykin, 1996, Chapter 11 (Method of Least Squares).

Paragraph beginning on page 12, line 28

Another channel estimation technique suitable for use with the present invention is described in U.S. Patent Application Serial No. 09/616,161, to Yakhnich et al, filed July 14, 2000, entitled "Method of Channel Order Selection and Channel Order Estimation in a Wireless Communication System," similarly assigned and incorporated herein by reference in its entirety.

Paragraph beginning on page 13, line 27

Several well known techniques can be used to provide soft symbol decisions from the inner decoder (or equalizer) that can then be used by a soft decoder. Most of these soft output ~~equalizer~~ equalization techniques are based on maximum likelihood sequence estimation (MLSE) or computational complex methods such as maximum a posteriori (MAP) algorithms. A few of these techniques are described below.

Paragraph beginning on page 14, line 24

For purposes of this description, it is assumed that soft decisions $s(k)$ 64 are available from the output of the inner decoder 54 (i.e. the equalizer). In the case that a hard decision equalizer is employed, it is assumed a soft output generator is used to generate soft decisions. A soft output generator suitable for use with the present invention is described in U.S. Patent ~~Application Serial~~ No. [[X]] 6,731,700, ~~filed X, to Yakhnich et al.,~~ entitled "Soft Decision Output Generator," ~~similarly assigned and~~ incorporated herein by reference in its entirety.

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Paragraph beginning on page 15, line 3

The normalized soft decisions 66 generated by the normalization module 56 are then input to the outer decoder 58 which is preferably an optimal soft decoder. The soft outer decoder functions to locate and fix errors using the redundancy bits inserted by the encoder. The outer decoder 58 generates the binary receive data 68. Examples of the outer decoder 58 include convolutional decoders utilizing the Viterbi Algorithm, convolutional Forward Error Correction (FEC) decoders, turbo decoders, etc. Soft input Viterbi decoders have the advantage of efficiently processing soft decision information and providing optimum performance in the sense of minimum sequence error probability.

Paragraph beginning on page 15, line 11

Note that optionally, an interleaver/de-interleaver may be added to the system. In this case, a symbol based interleaver/de-interleaver is used. If a bit based interleaver/de-interleaver is used, some mechanism of mapping soft symbols to bits must be used before the outer decoder. A mechanism of mapping soft symbols to bits suitable for use with the present invention is described in detail in U.S. Patent ~~Application Serial~~ Publication No. [[X]] US 2002/0122510 A1, ~~to Yakhnich et al., filed X,~~ entitled "Apparatus For And Method Of Converting Soft Symbol Information To Soft Bit Information," ~~similarly assigned and~~ incorporated herein by reference in its entirety.

Paragraph beginning on page 16, line 5

A block diagram illustrating an example of a slicer coupled to the output of a linear equalizer that may be used with the dynamic normalization function of the present invention is shown in Figure 4. In this example application, the linear equalizer circuit, generally referenced 90, functions to generate the input 96 that is used by the slicer 98 to generate the soft symbol decision information 102 input to the normalization module of the present invention. The input y_k (i.e. received symbols) 92 is input to the linear equalizer 94 ~~symbol by symbol slicer 72~~. The slicer 98 determines the symbol in the constellation closest to the received symbol, as represented by $A_{k,m}$ 100 where 'm' represents the number of symbols in the constellation. The output $A_{k,m}$ represents the hard decision as determined by the slicer.

Paragraph beginning on page 16, line 14

Both the received symbol y_k 96 and the sliced output $A_{k,m}$ 100 are input to an adder which functions to calculate the difference between the two, for each of the possible symbol values. The absolute value squared of each of the 'm' differences are then calculated. Note that for clarity, the adder and absolute value squared function block are incorporated into the slicer circuit 98. The

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resulting error values e_m^2 102 represent the soft decision information and [[are]] is subsequently normalized in accordance with the noise power estimate before being input to the soft decoder (e.g., convolutional Viterbi decoder).

Paragraph beginning on page 19, line 6

Typically, the path metric used by the outer decoder (e.g., Viterbi decoder) is given by the following expression

Paragraph beginning on page 19, line 23

Examining Equations 7 and 8, it is apparent that the path metric is actually the Euclidian distance divided by the noise variance. Note that the output generated by an equalizer is the Euclidian distance without division by the noise power. Therefore, in order to enable optimum operation of the subsequent soft outer decoding stage, the input soft decision information must be normalized (i.e. divided) by the noise power as illustrated in the receiver of Figure 2.

Paragraph beginning on page 20, line 3

An example receiver incorporating the normalization function of the present invention will now be described in more detail. A block diagram illustrating an example receiver with dynamic noise power estimation constructed in accordance with the present invention is shown in Figure 6. The receiver, generally referenced 130, comprises an Rx front end circuit 132, inner decoder 134, channel estimate 140, noise power/SNR estimation 142, noise power function block [[142]] 143, normalization gain adjustment block 136 and an outer decoder 138.

Paragraph beginning on page 20, line 9

The Rx front end 132 functions to generate samples $y(k)$ 144 from the signal received from the channel. The data related received samples are input to the inner decoder [[143]] 134 while the training sequence related received samples are input to the channel estimate 140 and the noise power/SNR estimation 142. The inner decoder comprises an equalizer adapted to output a noise power estimate 148 derived from the data in addition to soft decision information 146.

Paragraph beginning on page 21, line 22

$$\sigma_{Data}^2 = \left\| \hat{S}_{Data}(k)\hat{h}(k) - y(k) \right\| \quad \text{(11)}$$

$$\hat{\sigma}_{Data}^2 = \left\| \hat{S}_{Data}(k) * \hat{h}(k) - y(k) \right\| \quad \text{(11)}$$

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Paragraph beginning on page 25, line 18

In the receive direction, the output of the baseband codec is demodulated using a complementary 8-PSK demodulator 290. Several processes performed by the channel decoding block 292 in the signal processing section are then applied to the demodulated output to generate user data 294. The processes performed include burst disassembly, equalization, noise normalization in accordance with the present invention, soft symbol generation, soft symbol to soft bit conversion, de-interleaving, convolutional decoding and CRC check.

Paragraph beginning on page 26, line 3

In the receive direction, the signal transmitted by the base station over the channel is received by the receiver circuitry 286. The analog signals I and Q output from the receiver are converted back into a digital data stream via the A/D converter. This I and Q digital data stream is filtered and demodulated by the 8-PSK demodulator before being input to the channel decoding block 292. Several processes performed by the signal processing block are then applied to the demodulated output.

Paragraph beginning on page 27, line 14

In another embodiment, a computer is operative to execute software adapted to perform the noise normalization method of the present invention. A block diagram illustrating an example computer processing system adapted to perform the ~~reduced information packet~~ noise normalization method of the present invention is shown in Figure 12. The system may be incorporated within a communications device such as a receiver or transceiver, part of which is implemented in software.

Paragraph beginning on page 28, line 7

The ~~reduced information packet~~ noise normalization method software is adapted to reside on a computer readable medium, such as a magnetic disk within a disk drive unit. Alternatively, the computer readable medium may comprise a floppy disk, Flash memory card, EEPROM based memory, bubble memory storage, ROM storage, etc. The software adapted to perform the noise normalization method of the present invention may also reside, in whole or in part, in the static or dynamic main memories or in firmware within the processor of the computer system (i.e. within microcontroller, microprocessor, microcomputer, DSP, etc. internal memory).

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